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Typed Name: Kevin D. McCarthy
Date: December 22, 2008

Patent

0-05-213 (16020/US/03)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: Rakhman et al.
Serial no.: 10/561,825
I.A. Filed: July 8, 2004
Title: PROCESS FOR MAKING THERMOPLASTIC
VULCANIZATES
Examiner: Lenihan
Art Unit: 4171
Confirmation: 3527

Commissioner for Patents
P.O. Box 1450
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Dear Sir/Madam:

AFTER- FINAL RESPONSE AND AMENDMENT

This response is in reply to the final office action mailed on December 2, 2008.

Claim Amendments

Please amend the claims as shown in the enclosed document.

Claim Rejections under 35 USC §102

The Examiner rejects claims 24, 25, 28-30 and 36-38 as being anticipated by Bernhard Rustige GmbH & Co KG (DE4402943).

The Applicant notes that DE4402943 relates to a polymer composition comprising a matrix phase component and a silane cross-linked dispersed phase component. However DE4402943 does not mention a polymer composition having a silane cross-linked dispersed phase with a cross-linked density of at least 5×10^{-5} mol/cm³, as specified in amended claims 24 and 25.

The Applicant respectfully submits that an averaged skilled person in the art would understand that this particular characteristic is obtained when employing the process of the present invention and not processes disclosed in the prior art, and in particular not the one recited in DE4402943. As specified in amended claim 1, the present process comprises a fast and very efficient cross-linking step of the silane with the dispersed phase component, said step being carried out in the molten state of the disperse phase component, in the absence of water addition, and by using a cross-linking agent comprising an acid in a weight ratio of from 1:3 to 1:1 with the organic silane. The conditions disclosed in the process of the invention are essential to achieve the desired cross-linked density of the disperse phase, as for example, the use of other cross-linking agents does not enable to reach the desired cross-linked density (see Table 8 of the application).

Therefore, as the process of claim 1 is acknowledged as novel over DE4402943, the limitation of claims 24 and 25 reciting that the dispersed phase component has a cross-linked density of at least 5×10^{-5} mol/cm³ would not be inherently present in the polymer composition of DE4402943, and claims 24 and 25 are believed to be novel and non-obvious.

Claim Rejections under 35 USC §103

The Examiner rejects claims 26, 27, 34, 35, 40 and 41 as being unpatentable over Bernhard Rustige GmbH & Co KG (DE4402943)

The Applicant respectfully submits that in view of the above explanations and further in view of amended claims 24 and 25, the objected dependant claims are also novel and inventive over DE4402943.

The Examiner rejects claims 31 and 39 as being unpatentable over Bernhard Rustige GmbH & Co KG (DE4402943) in view of Coran et al. (US 4183876).

As it is believed that claims 24 and 25 are novel and inventive, claims 31 and 39 are also novel and inventive.

The Examiner rejects claims 1-4, 6-17, 19-21, and 33 as being unpatentable over Bernhard Rustige GmbH & Co KG (DE4402943) in view of Tsumura et al. (US 5623030).

DE4402943 (Fritz et al.) uses silane wetting (page 3, lines 16-17) and teaches that catalytic reagents, such as organic acids or amines, may be added to shift the pH value of the wetting solution into the acid or alkali region. Therefore, in contrast to the process disclosed in the present invention, the process of DE4402943 requires the addition of water by wetting to obtain the desired results.

US 5,623,030 (Tsumura et al.) discloses compositions with and without water, while teaching the advantages of water addition for accelerating the hydrolysis of the alkoxysilyl groups (col. 13, lines 29-36). Tsumura et al. use silanol cross-linking catalysts in the amount of 0.01-20 parts by weight to 100 parts of siloxane component (col. 12 lines 66-67 and col. 13, lines 1-2).

In contrast, the present invention uses a weight ratio of cross-linking agent to silane from 1:3 to 1:1 (page 7, lines 19-20 and page 8, lines 1-2). This ratio, in combination with other elements disclosed in the present invention, provides very fast and full cross-linking of the thermoplastic polymer. Tsumura et al. teach that cross-linking process lasts tens of hours (col. 14, lines 24 and 40-42). In contrast, the dynamic vulcanization process of the present invention, in particular in continuous mode, enables the cross-linking step to be completed within the residence time in the extruder, *i.e.* between a minute to half an hour (page 11, line 25).

The Applicant respectfully submits that amended claim 1 discloses a process for the production of thermoplastic vulcanizates having a matrix and a disperse phase component, said process comprising a silane cross-linking step of the dispersed phase component essentially characterized in that:

- a cross-linking agent comprising an acid is employed;
- the weight ratio of said cross linking agent to said organic silane is from 1:3 to 1:1;
- the duration of said cross-linking step is from a minute to half an hour.
- the reaction is carried out in the molten state of the dispersed phase component; and

- no water is added during the whole process and no water is present the cross-linking step.

The Applicant respectfully states that neither DE4402943 nor US 5623030, or any combination of the above-cited publications, teach or suggest all the above-mentioned criticalities in production of thermoplastic vulcanizates. Therefore, starting from the closer prior art, namely DE4402943, an averaged skilled person in the art would not have found in US 5623030 the technical elements to obtain the process of the present invention.

For the sake of clarity, the Applicant respectfully directs the attention of the Examiner that the present invention, relates to dynamic vulcanization (see claim 1), also called dynamic cross-linking.

Dynamic cross-linking relates to a process where cross-linking is performed inside a mixing device, such as an extruder or a batch mixer, with intensive mixing, and should be totally completed during the mixing session in order to fix the structure of the product. In this case the cross-linking step duration is of crucial importance, as the mixing devices have a limited volume. Therefore, cross-linking reactions lasting hours are not efficient and feasible in the industry. Usually, residence time varies from one minute for continuous mixers to quarter an hour for batch mixers. It is extremely important to complete the cross-linking reaction within the mixing session, because static post-curing may change the material structure and cause lack of processability of the resulting material (it becomes not thermoplastic, and cannot be regarded as thermoplastic vulcanizate).

Tsumura's invention does not teach performing dynamic cross-linking, and relates to static cross-linking which lasts tens of hours. Furthermore, silanol condensation mentioned in Tsumura's patent, is known as slow reaction, triggered by hydrolysis of silanol groups, which lasts from hours to weeks, depending upon conditions.

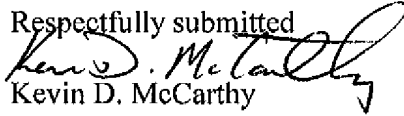
The unique combination of the invention comprising a specific cross-linking agent comprising an acid (e.g. boric acid) and a specific weight ratio of cross-linking agent to silane that allows to reduce drastically the cross-linking time from tens of hours to tens of seconds and provide complete and effective (in the terms of cross-link density) cross-linking of the disperse phase within the residence time in the mixing device. Neither Bernhard Rustige GmbH & Co. KG, nor Tsumura are suggesting or teaching such combination.

In view of the above explanations and amendments, the Applicant respectfully submits that amended claim 1, as well as all the claims dependent therefrom, are non-obvious in view of the cited prior art.

Conclusion

As it is believed that all of the rejections set forth in the Office Action have been fully addressed, favorable reconsideration and allowance are earnestly solicited.

Respectfully submitted


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